United States Patent [19]

Ariano et al.

[54] **ELECTRONIC DEVICE FOR THE SIMULATION OF AN ANIMATED GAME, IN PARTICULAR THE GAME OF FOOTBALL**

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[51] Int. Cl. **A63f 9/00**
[58] Field of Search .... 273/1 E, 85 R, DIG. 28; 340/324 A

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[57]   **ABSTRACT**

An electronic device is disclosed which can simulate any animated game between two single players or two teams. Said device can be preselected for three types of game; manual with the direct piloting by two rival operators; semiautomatic wherein only one operator pilots his player or team against the automatically piloted adversaries; automatic wherein the game has no intervention from man. OR circuits, logic and memory blocks, through suitable decoding and amplification circuits set the zone of the playground wherein play will take place at a given moment and the relevant signals are represented on a visualization plane by distinct luminous points or on a television cinescope by a continuous display, preferably in a polychromatic manner.
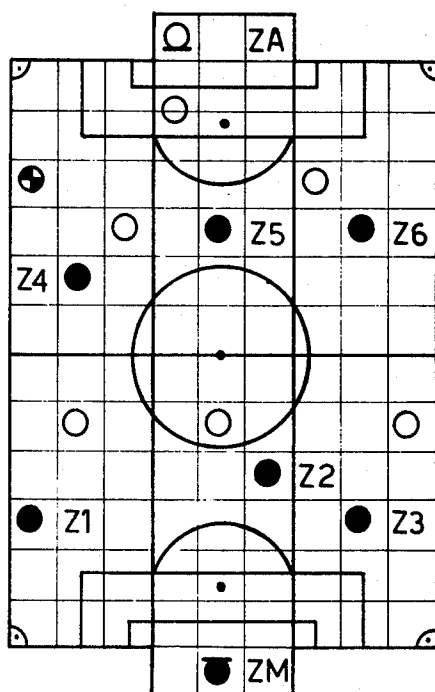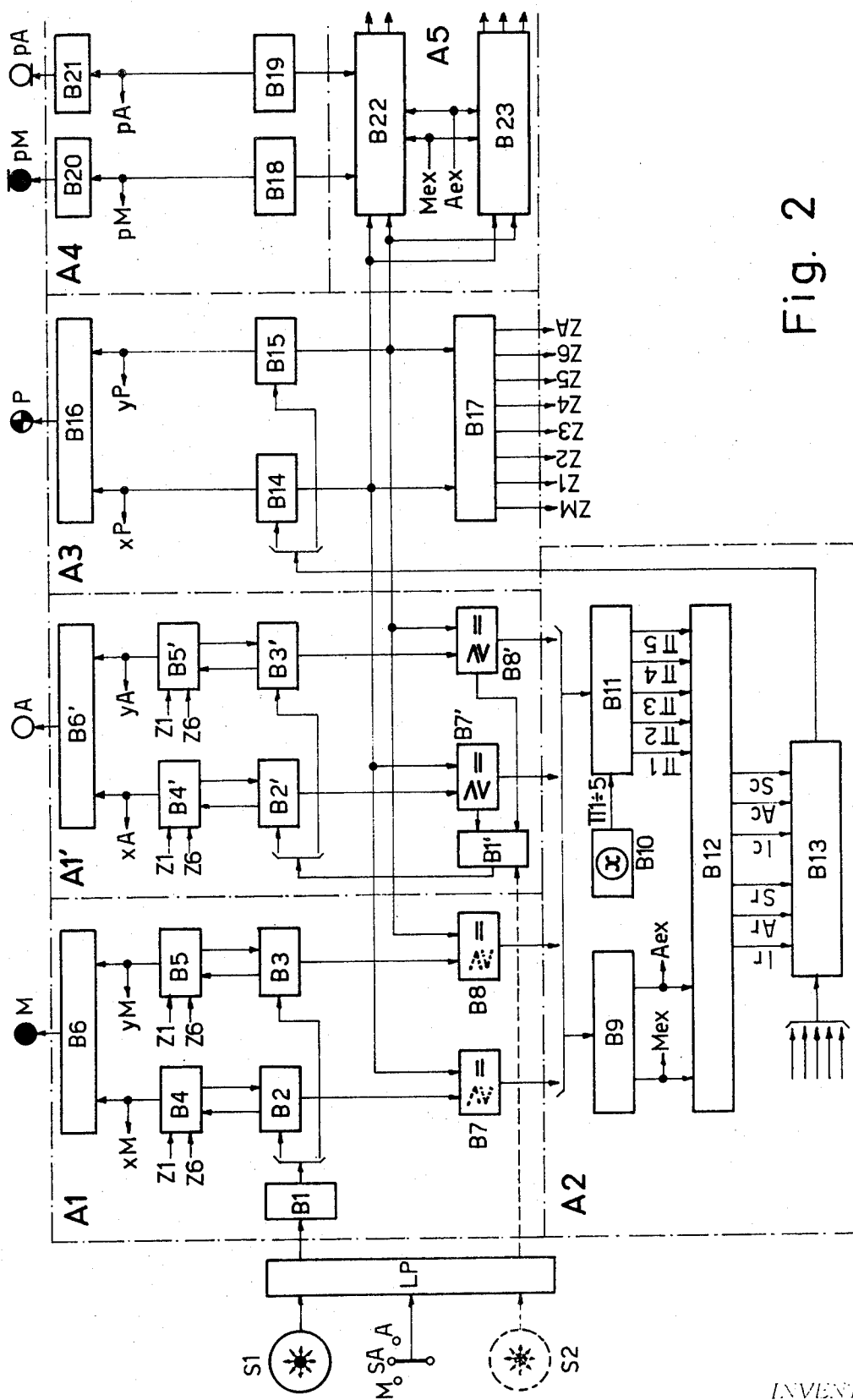
12 Claims, 7 Drawing Figures
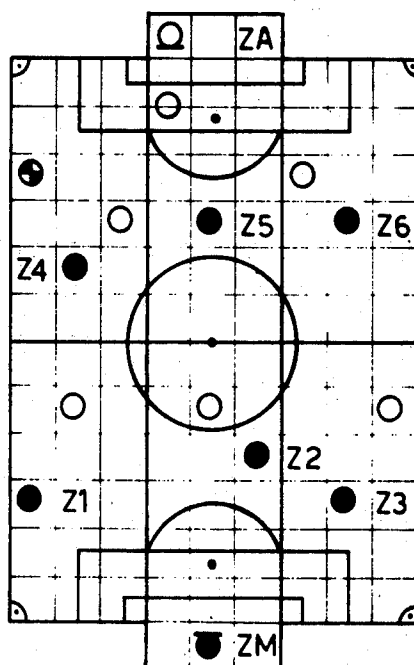
Fig. 1

INVENTORS

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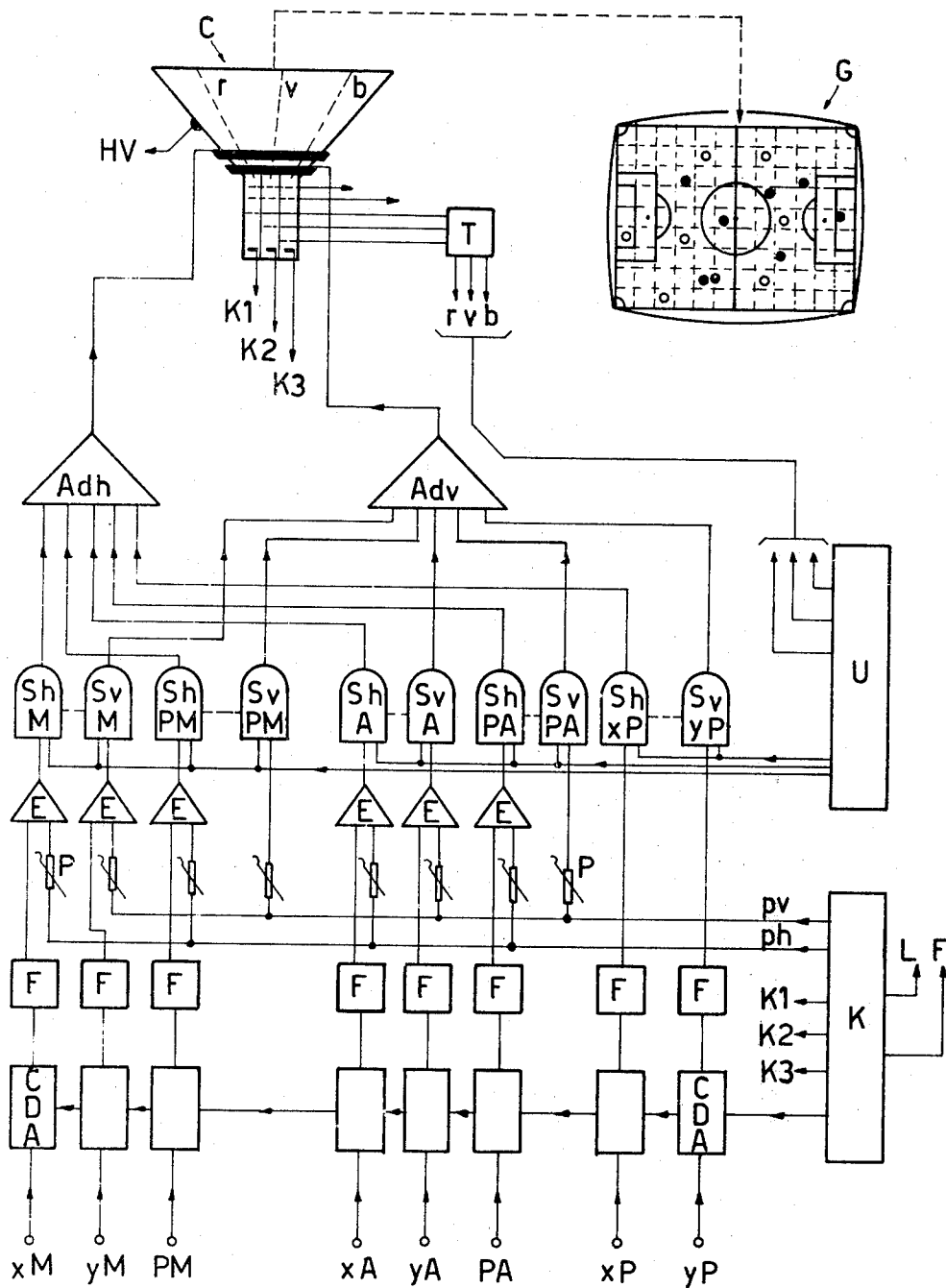Bartolomea Fontanella

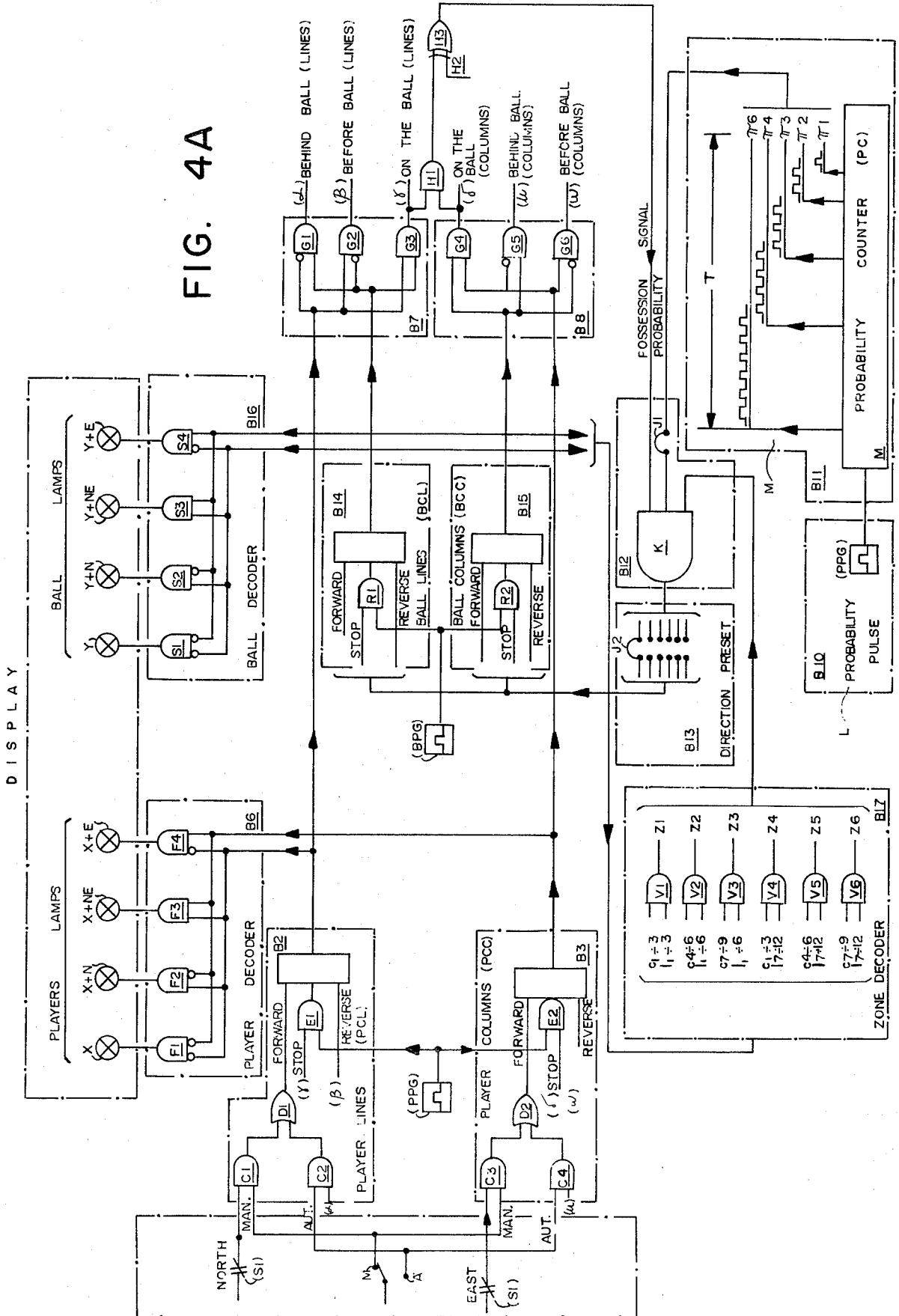BY Broudy and Neimark

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Fig. 2

Fig. 3

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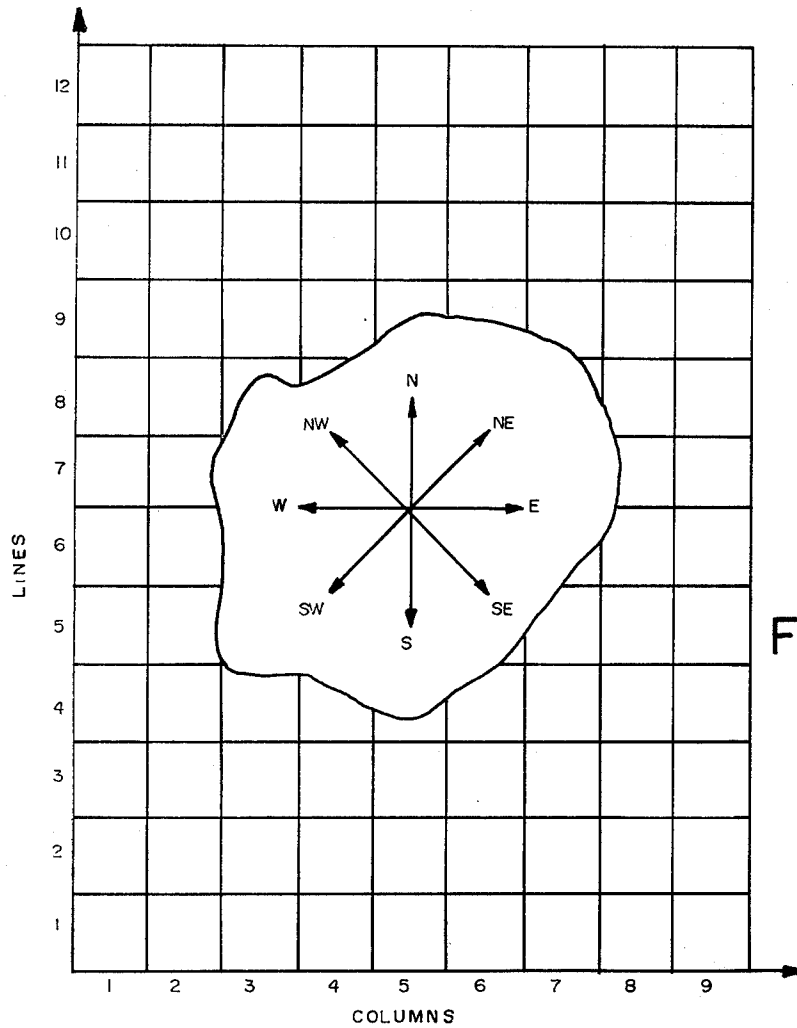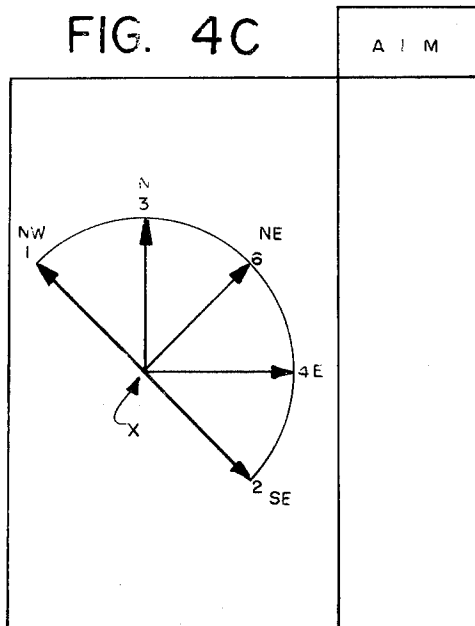Browdy and Neimark
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FIG. 4A

FIG. 4B

FIG. 4C

AIM

FIG. 4D

LEGEND

AND · LOGIC

OR · LOGIC

EXCLUSIVE · OR

FLIP-FLOP
(COUNTER)

INVERTER

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ELECTRONIC DEVICE FOR THE SIMULATION OF AN ANIMATED GAME, IN PARTICULAR THE GAME OF FOOTBALL

BACKGROUND OF THE INVENTION

The present invention relates to an electronic device capable of automatically simulating a sports match, in particular a match between two adversaries or rival teams, and more particularly a soccer match.

At present in commerce, especially in public places, machines which aim to simulate sports matches such as table football, pinball etc. are well known. These machines are based on electromechanical systems which present the disadvantage of not being able to imitate the game in such a way as to reproduce reality with sufficient realism. In fact, none of the machines existing at present is capable of endowing the moving bodies in a game which is manifested in multiple elements of movement, a movement which results naturally in a satisfactory manner avoiding at the same time the phenomena of mechanical friction which are always present. Moreover, the machines existing at present for the simulation of animated games are either completely passive with respect to man, who must each time intervene with his own intelligence to give to the chosen piece the desired movement, bearing in mind also the rules of the game, or present a limited grade of automation.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a machine for the simulation of animated games which allows the elimination of any element which might generate friction, thanks to the use of static electronic components.

Another object of the present invention is to provide a machine which is not a passive element for man, but on the contrary can react to the different situations of the game according to the rules of the game itself.

According to the invention, the possibilities of the game can be theoretically infinite, as can the actions and reactions of each single player, respecting all the rules laid down by the ruling which are not comprised within the scope of this invention and in practice will be limited solely for economic reasons but not for conceptual reasons.

This is achieved through the use of the most advanced techniques, such as integrated circuits on module cards with printed circuit, magnetic memories, trnasistors and in general solid components exploiting modular techniques which are the most recent novelties in the field of industrial components suitable for resolving logical problems.

It is not to be excluded however that at least partly the circuits and the blocks defined hereafter are realizable with electromechanical components (relays etc.) rather than electronic.

Another fundamental characteristic of the device according to the present invention regards the representation of the game which takes place on a plane and is visualized through the use of conventional luminous points of a proper colour and form, capable of simulating the bodies in movement or by means of a television representation which would give a "continuous" simulation of the mobile bodies.

A most important advantage of the machine according to the present invention is that of giving the possi-

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bility of choosing one among three different programmes of play through the operation of a single selector. These three programmes for the operation of the machine are: "manual" in which two operators respectively pilot one of the two rival teams; "semiautomatic," in which an operator pilots a team against the rival team piloted completely automatically; "automatic" in which two rival teams compete between themselves without any external intervention from man.

In order to give a simple valuation of the capacities and means of representation of the device, the following description refers to the game of soccer, certainly the most widespread and well-known throughout the world, naturally without excluding the fact that the same principles can be applied, with the necessary modifications, to other games such as baseball, rugby, etc. or even more simply to games between single adversaries such as tennis.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be fully described in relation to an embodiment and two different systems of visual representation, given by way of a non-limiting example of the invention, with reference to the attached drawings, in which:

FIG. 1 shows the plane of representation of the field of play for the simulation of a soccer game between two teams, each of seven elements;

FIG. 2 represents the general block diagram of the machine according to the present invention in the case of "semi-automatic" operation;

FIG. 3 represents a functional scheme for the tranformation of the information from the block diagram of FIG. 2 into signals capable of being continuously displayed through a television cinescope;

FIG. 4A is a detailed representation of the basic circuits of the machine;

FIG. 4B is a representation of an example of the various play-zones in relation with the outputs of the line and column counters for the ball; and

FIG. 4C shows an example of allocation of the probabilities relating to the direction of movement of the ball for reaching an aim from any point X of a generical zone.

FIG. 4D Shows the legend.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 shows the plane of the playground subdivided into 6+2 parts (zones) for a match between two teams, each of seven elements. Of course the game could also take place between two teams of 11 elements, in which case the zones would be 10+2, this being considered a simple extension of the case described without involving any conceptual modification. The players of the team M are indicated with black rings and the players of the team A with white rings, while the black and white ring represents the ball. According to the figure, the field is subdivided into six equal zones Z1÷Z6, three on one side and three on the other with respect to the central line, as well as two extreme zones ZM and ZA reserved for the goal-keepers. In each of these six zones a pair of players from the rival teams can move, as for example the right back of team M and the left wing of team A and viceversa, or the center half-

back of team A and the centre forward of team M and viceversa.

It should be remembered that each of these pairs of players has autonomy only in its own zone which limits the area of action of both. The ball on the other hand has a liberty of maneuver (that is it can move) on all the field, occupying any zone. The zone which in a given instant is occupied by the ball becomes automatically "active", that is only the two players relative to that zone compete directly for the possession of the ball and successively to effect a "rational" step to other zones or towards the opposite goal.

Manual operation

In this case the operator has only a limited possibility of intervening directly in the game as certain functions will remain completely automized in order to obtain an equilibrium of forces and to introduce the probabilistic factor into the game for both teams. In fact, in this case, the operator can act only upon a selector with eight positions (N-NE-E-SE-S-SW-W-NW) and a neutral (see FIG. 2). In this way, the operator can in every instant impose only the "direction" that must be followed by this own player in the active zone, while the other actions take place in a completely automatic and rational manner, that is according to the reality of a soccer match. These actions are: the advance of the player himself, the acknowledgement of the possession of the ball, the direction in which the ball in possession is kicked. In the case of the "manual" game, also the adversary operator will have at his disposition a selector with which he will be able to pilot the players of his own team. For this type of game all the game rules previously introduced will be respected automatically and equally, in particular the points will be counted automatically, and the game will cease automatically when a certain time established at the beginning has elasped; the score acquired by the two teams will determine the victory of one or a draw.

Semi-automatic operation

The game takes place as described in the "manual" case, with the only difference that one operator pilots his own team against an automatic adversary which controls the other team. The game is therefore characterized by the antagonism between man and machine which should make this type of action interesting and appealing. We have tried to maintain certain conditions of equality in such a game, as on one hand limited possibilities of operation are given to man and on the other hand, for the automatic adversary there is a limited, even if precise, intelligence in the execution of the maneuvers. Moreover for both teams probability conditions have been introduced in order to avoid a constant prevalence of play for one of the two parties. For example, the machine could erroneously be conceived in such a way that when one player enters in possession of the ball, he infallibly kicks it into the goal scoring a point. Instead, to make the game more realistic and interesting, as will be described in detail hereafter a generator of probability has been introduced which, for example according to the position of the ball, the zone occupied and the player who has taken possession of the ball, determines the direction in which the ball will be kicked in a probable and rational manner. At the end of every action (goal, off-side, corner etc.) the ball will take up a proper position according to the rules of football.

ball. While the players under control of the operator receive directly from him the direction of movement required, those of the automatic adversary receive orders from special circuits which compare the position of the players with that of the ball and which will be described hereafter with reference to the block diagram of FIG. 2 and even in greater detail with reference to FIG. 4A.

Automatic operation

The competition takes place as described for the "semi-automatic" game, the only difference being that two automatic adversaries pilot their respective teams without the intervention of man.

Choice of the type of operation

One or the other of these basic programmes of operation, (manual, semi-automatic or automatic) can be chosen acting on a pre-selector with three position M-SA-A placed at the input to a block LP of programming logic. The FIG. 2, which represents the general diagram of the machine, refers to the "semi-automatic" programme which is the most complete as it includes as secondary cases the "manual" and "automatic" programmes. In this type of operation one of the two manual selectors (S2) is excluded and the blocks B7 and B8, identical to the blocks B7' and B8' operate only as "coincidence" circuits and not in the general sense of "comparison". The parts of the diagram not in function in the case given as example have been drawn in dashed lines and it will be simple even from reading the following description to understand how the diagram itself will be modified in the other two programmes of play.

Description of the block diagram

Referring to FIG. 2, the selector operating for the "manual" programme is indicated by S1 while the complex of the sub-circuits included in the area A1 represent the logic of piloting the players of the team M (manual) relative to the operator. In particular, the block B1 decodifies the eight above-mentioned directions which can be chosen by the operator himself through the selector S1 and also executes the control of the chosen direction. The selectors S1 and S2 comprise four contacts, two of which (N, S) actuate, as will be better explained with reference to FIG. 4A, line counters and the other two (E, W) column counters. The two contacts of each pair of contacts cannot be closed at the same time but so can N with E or W as well as S with E or W. The signal corresponding to the selected direction (among the possible eight) reaches blocks B2 and B3 wherein it is translated into a command for "forward" or "back" or "stop" for the reversible line and column counters contained respectively inside these blocks. In FIG. 4 block B2 comprises circuits C_1, C_2, D_2, E_1, PCL and block B3 comprises circuits C_3, C_4, D_2, E_2, PCC.

Since, as it has been said above, only one player of a team is active at a time, and precisely that in whose zone the ball is, to be able to represent the other players as well, the same amount of groups of "memories" are necessary, represented by the blocks B4 and B5 respectively relative to the lines and the columns. The use of these memories is to be considered only as a technical expedient for saving counter circuits: if each player had his own counter (as in the example of FIG. 4A), these memories would not be necessary.

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Each of these memory groups becomes active when the ball is in the corresponding zone Z1÷Z6. The outputs of each memory group form the lines and columns of a matrix whose intersections xM and yM give, by means of a subsequent stage of amplification (block B6), the representation of the players of team M. In FIG. 4A block B6 comprises circuits F_1, F_2, F_3, F_4 relating only to one player. The circuits G_1, G_2, G_3 and G_4, G_5, G_6 contained in the blocks B7 and B8 serve for the connection of the complex of the circuits contained in the area A2 relative to the logic of piloting of the ball and contain the coincidence circuits for checking the position of the player M with that of the ball P respectively for the lines and the columns. When this coincidence is verified, it means that the possession of the ball by M has been realized and in this case the outputs of B7 and B8 transmit a signal of "coincidence taken place" to the area A2.

As in the same minimal interval of time necessary to permit the visualisation on the representative plane, a "coincidence" for the other rival player present in the same active zone could take place, in order to define which entered into possession of the ball first, OR exclusive circuits contained in the block B9 are used, whereby only one of the two outputs Mex or Aex of this block will be active at every moment. The block B9 in FIG. 4A is only partially represented by an AND circuit H_1 the output of which is one of the two inputs of a OR exclusive circuit H_3. The other input of H_3 is given by a (not shown) AND circuit H_2 relating to the other team's player.

The "probability generator" of the block B10 is obtained by codifying in a different manner on five distinct paths ($\pi_1 \mp \pi_5$) a train of impulses originated by a known high-speed generator. By means of the circuits inside block B11 one of the above-mentioned five paths, which are non-coinciding, numerically different impulses in time, is selected and memorized in the moment in which the coincidence "playerball" takes place. The block B10 is indicated by L and block B11 by M in FIG. 4 where the operation of the "probability generator" is better represented. The probability acquired in this manner is utilized by the circuits of block B12 to give the direction towards which the ball will move by means of a "topographical decodifying" variable according to the zone at that moment of interest, or according to the zone occupied at the moment in which the possession of the ball by the player takes place. In the topographical decodifying of block B12 obviously which rival player takes "possession" is also taken into consideration. The block B12 is defined in FIG. 4 by a three-input AND circuit K.

An example will be given now to better explain this point: if the centre forward of team M gets the ball, and is near the opposite goal, it is very probable that he will tend to kick directly into the goal, less probable that he will pass to a companion by the side of him and finally improbable that he will kick the ball backwards. His behaviour will therefore be substantially different e.g. from that of the right wing who will try to kick the ball towards the left, and completely opposite to the behaviour of the centre forward of the opposite team. This means that it is necessary to consider the topographical position of the active zone discriminating therefore the role assigned to each player.

The practical realization of that which is described above takes place by means of combinatory networks

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utilizing active NAND circuits and diodes contained in the block B13, schematically represented in FIG. 4 by connection circuits J_2. In the definitive, the task of all the circuits contained in the area A2 is that of determining from time to time towards which direction the ball will be kicked when it is in the possession of any one of the players. The output of block B13 will therefore give the "forward" (Ar, Ac), "stop" (Sr, Sc) or "back" (Ir, Ic) instructions to the reversible counters respectively of lines and columns relating the ball signal, represented by blocks B14 and B15 contained in the area A3 relative to the ball. The outputs xP and yP of these counters, similarly to what has been stated above for xM and yM, combined in "line and column" matrixes and amplified in a transistorized circuit B16 will give a representation of the ball. In FIG. 4A the block B14 is given by circuits R_1 and BCL and block B14 by circuits R_2 and BCC, while the circuits of the block B16 are those identified with S_1, S_2, S_3, S_4. It is to be noted that as the ball is only one, it is not necessary to provide memories for the representation of the ball position, as instead was necessary for the players (blocks B4, B5, B4', B5') in order to reduce the number of counters employed.

That which has been stated for the area A1 of the "manual" player is also true for the "automatic" player whose area is indicated by A1', with the only difference that while the operator sees and decides the direction towards which his own player M must move to possess the ball, this perception will be given to the automatic player by the "comparison" circuits contained in B7' and B8'. These, in addition to carry out the task of valuing the difference between the distance "automatic player-ball" and to transmit the information to the pilot circuit in B1' signal to the circuits of the area A2 when the "coincidence" takes place analogously with that which happens for the equalizer circuits B7 and B8 of the area A1. All the other circuits contained in the block B2'÷B6' carry out functions identical to those described for the corresponding blocks of the area A1 and therefore are not represented in FIG. 4. To establish which of the zones (Z1÷Z6, ZM or ZA) of the field is active at a given moment, or is occupied by the ball, a complex of OR circuits at the output of the ball counters BCL, BCC and of AND circuits V_1–V_6 (FIG. 4A) are used as will be better explained.

As far as the two goal-keepers PM and PA are concerned, a mobility within the area of the respective goal not closely limited to a possible goal kick is obtained, by means of the circuitry of the blocks B18 and B19 being conventional oscillators at modulated frequence with relative amplifiers B20 and B21 for the lighting of the visualization lamps, contained in the area A4. In this way the possibility of being able to save the ball is not certain. In the diagram illustrated in FIG. 2, the possibility of moving only along one of the co-ordinates and precisely along the abscissae axis is given to the goal-keepers.

The rules of the game (in this case the soccer) are observed by means of the circuitry of the blocks B22 and B23 in the area A5 and in spite of the fact that they constitute one of the most remarkable attributes of the present device, they are almost all realized by means of simple technical expedients as all the circuits described above have a high "logical flexibility." For example, the "ball out of side" or the "corner" and therefore respectively the "throw-in" and the "corner kick" are

registered by the machine considering that the playground is extended by a further fictitious quantity along its whole perimeter; this is technically the same as extending the count of the counters of the ball. These functions are carried out by means of an initial "set" of the flip-flops of the counters, both for the ball and for the players and by means of a probabilistic logic for the ball kick, using the same generator B10 of the area A2 analogously with that which has been said in precedence. With similar technical expedients all the other main rules of the soccer game are realized.

Detailed description of the basic circuits

With reference to FIG. 4A the basic circuits represented in the block diagram of FIG. 2 are fully described in their operation, with reference to only one player of a team for the sake of simplicity and clearness. All that which will be stated may be extended to the other players in order to obtain the complete operation of the machine. Some technical expedients have been only omitted, which are however obvious to a man skilled in electronics.

The operation and the parallel description of the circuits has been considered subdivided in four steps, i.e. the movement of a generic player, the movement of the ball, the possession of the ball by a player and the kick of the ball after possession.

Movement of a generic player

In FIG. 4A the position occupied at a given moment by a generic player on the play-ground is indicated with X. It is supposed that the operator, after having preset the type of operation in "manual" bringing the selector M-SA-A of FIG. 2 to the position M, wants to displace this player X (of his team) towards positions to the north of X, which are indicated by X+N (see also FIG. 4B). In order to achieve this, it is sufficient to bring the control selector S1 in the position N. Thus the contact NORTH (S1) is caused to close and the input 1 of the AND circuit C_1 ($1C_1$) is biased. As the other input $2C_1$ is already enabled, because we have supposed to be in the manual operation (contact M closed), the output $3C_1$ becomes true and therefore also the input 1 of the OR circuit D_1 ($1D_1$). The output $3D_1$ sets the "forward" counting of the counter PCL relating to the lines of the player signal.

An unstable generator PPG sends impulses (1 ∓ 3 Hz) coming to the clock input of the counter PCL which is caused to be actuated in the forward direction for a given number of counting steps to light progressively one of the lamps placed to the north of X. When the operator wants to stop the advancement of the player signal, it will be sufficient to release the selector lever from the position N and to bring it to the central "neutral" position. In this position, as well as in the E or W position, when only the contact relating the east or the west direction is respectively closed, a control signal of STOP is given to the counting operation of the counter PCL, thus inhibiting through $1E_1$ (input 1 of the AND circuit E_1) the passage of the impulses to $2E_1$ from the oscillator PPG.

It is intended that another group of circuits C_1–C_2–D_1 is provided (not shown in the drawings) also for the REVERSE input of counter PCL, with reference to the positions of the selector lever which are of interest for the direction to the south: S-SE-SW. These three circuits are also provided at the STOP input of PCL,

which is on either when no contact of the selector is closed, i.e. the control lever is in the "neutral" position, or when the E or W contact is closed as already stated. These further two groups of circuits are not represented for the sake of simplicity.

If the operator wants that his player moves along the east direction, he will bring the control lever of the selector to the E position (contact E closed). In this case, the counter PCC, relating to the columns of the player signal is set to FORWARD through the way $1C_3$–$3C_3$–$1D_2$–$3D_2$, enabled by $2C_3$, and the lamps to the east of X will be lighted (X+E). As stated above for PCL, the group of circuits C_3–C_4–D_2 are also provided for the REVERSE input of PCC, i.e. for the lever positions relating to the west direction (W-NW-SW). A group of two AND circuits and one OR circuit is also provided at the STOP input of PCC, which is actuated either when no contact of the selector is closed (lever in neutral position), or when one of the contacts S or N is closed.

If the operator wants instead that his player moves along the NE direction, the inputs of both the counters PCL and PCC will be set to FORWARD, thus giving a diagonal direction to the north-east (FIG. 4B) to the luminous point departing from X.

All that has been stated so far in relation with the positions N, E, NE may be easily understood also in relation with S, W, SW positions. Furthermore the operation of counters PCL, PCC is the same if the "automatic" game is preset on the M-SA-A selector, the only difference being that the information of FORWARD, REVERSE and STOP will not be caused by the operator, but chosen at every instant by the "comparison" circuits in B7, B8 as it will be explained in the following, by automatically estimating the difference between the positions of the player and the ball signal. For example the information of automatic piloting towards the north is represented in FIG. 4A by signal α entering $1C_2$ (input 1 of AND circuit C_2), analoguous to $1C_1$ in the manual operation.

Movement of the ball

On the contrary the counters BCL relating to the lines and BCC relating to the columns of the ball signal are always automatically operated. The ball is supposed to be in a generic position Y and the input 2 of BCL is actuated (FORWARD direction) whilst the input 1 (STOP) of BCC is on. Each impulse from the generator BPG, which is again of the unstable type at a frequency of 1–5 Hz, causes a counting of BCL, i.e. an advancement of the lines relating to the ball signal towards positions to the north of Y, i.e.: Y+N. On the contrary if only the input 2 of BCC were enabled, the advancement of the columns would result in the same manner and the ball signal will move towards the east (Y+E, see FIG. 4B). If both the inputs 2 of BCL and BCC were enabled at the same time, a movement along the direction north-east would result (Y+NE).

Similarly it is to be understood that if only the counter BCL were enabled in the REVERSE direction (input 3) a displacement to the south would result, if only the input 3 of BCC were enabled, the result would be a westwards movement, whilst from a combination of the two actuations the ball signal would move along the south-west direction. The decoding of positions relating to the ball is carried out by the logic circuits S_1, S_2, S_3, S_4.

Entering into possession of the ball by a generic player

Through the continuous comparison between the position (that is the content) of the counter PLC and the counter BLC, both relating to the lines respectively of the player and the ball signal, the following possibilities may be met: a. the counting the PLC>counting of BLC, i.e. the player signal is in such a position that its line number, for example in a line numbering as in FIG. 4B, is less than the line number of the ball signal (player behind ball, or to the south of the ball). In the automatic operation this situation corresponds to a logic 0 at the input 1 of all the AND circuits G_1, G_2, G_3 and a logic 1 at their input 2, which causes G_1 to switch. The signal α obtained at the output of G_1 controls the forward actuation of PCL, i.e. a northwards movement of the player signal, by means of a direct connection between $3G_1$ and $1C_2$.

b. The counting of PCL>BCL counting. It means that the position of the player signal has a line number (see FIG. 4B) higher than the ball signal, i.e. it is to the north of the ball. In the automatic operation this corresponds to the switching of the AND gate G_2 the output of which $3G_2$ is connected with the input 3 of PCL. The signal (β) for controlling the reverse operation of the counter PCL passes through a not represented way consisting of circuits corresponding to C_1, C_2, D_1 and similar thereto, as previously stated. The southwards movement of the player is thus obtained.

c. PCL counting = BCL counting. It means that the player signal has the same line number as the ball signal (partial possession as to the lines). In the automatic operation the AND gate G_3 is switched. The output $3G_3$ is connected, again through a group of circuits corresponding to C_1, C_2, D_1, not shown, to the input $1E_1$ and the signal (γ) controls the counting stop of PCL.

In a similar manner the above-mentioned cases a), b), c) may be repeated for the column counters PCC and BCC with reference to the east direction instead of the north and the AND gates G_5, G_6, G_4 with the corresponding output signals μ, (ϵ), (γ) instead of G_1, G_2, G_3 and α, (β), (γ).

Furthermore, when both PCL = BCL and PCC = BCC occurs, $3G_3$ and $3G_4$ enable the AND gate H_1 relating to the possession of the ball. As previously stated, in order to avoid the contemporaneous possession of the ball by two adversary players, the outputs of H_1 and an analoguous AND gate H_2 (not shown) connected with the circuits of $B'7$ and $B'8$ relating to the player of the adversary team which is in the same zone (not represented in FIG. 4A) are the inputs of a OR exclusive gate H_3 the output signal of which gives the information of "player on the ball" and "which player is on the ball first." A possible subsequent possession of the ball also by another player has no consequence.

Kick of the ball after possession

This stage occurs always automatically, also in the manual operation, as well as the identification of the ball possession. Only the movement of the players toward the ball can be controlled by the operator in the manual operation. Before describing how the ball is kicked after the possession has taken place, it is convenient to study the following two circuits:

a. decoder of the ball presence in one of the zones Z1 to Z6. The visualization plane has been divided for example in 3+3+3 = 9 columns and 6+6 = 12 lines. (FIG. 4B), that is in 6 zones defined by the different combinations of 3 columns and 6 lines. The presence of the ball in one of the 6 zones is therefore detected by decoding and combining the content (counting) of the two ball counters BCL and BCC. For example, when one of the columns C_1 OR C_2 OR C_3 AND one of the lines I_1 OR I_2 OR I_3 OR I_4 or I_5 OR I_6 are active, the inputs of the AND circuit V_1 are enabled (logic 1 signal) and the output signal from V_1 represents the ball present in the zone Z_1. Similarly the presence of the ball in any of the other five zones is detected, by means of a signal at the output of one of the gates $V_2 - V_6$, corresponding respectively to the zones Z2 - Z6.

b. Probability generator. We consider the time as a succession of periods T, each period T being divided in 16 equal sub-periods. These 16 sub-periods may be grouped respectively into groups formed by 6, 4, 3, 2, 1 sub-periods for each period T, which will be called "probabilities" and respectively indicated by the symbols π_6, π_4, π_3, π_2, π_1. A simple 4-bits binary counter PC, permanently fed by an inpulse source PPG (having frequency of about 1Hz) will give rise to the counting of 16 impulses in each period T. By means of selecting and decoding the first 6 impulses, then the subsequent four etc. through five different ways, 5 different - weighed probabilities are obtained, which will come true cyclically.

The probability is rigidly allotted to each of the possible five directions (FIG. 4C) in any of the six zones, and in different manner for the two teams. Therefore $5 \times 6 \times 2 = 60$ allotments are possible by means of 60 AND type circuits (in FIG. 4A only one is shown, i.e. K) with three inputs (zone, probability, team of the player which first has been on the ball). The connections J_1 (diodes) give the five probabilities from B11 to the 60 circuits K, the outputs of which, through the connections J_2 (B13), i.e. a matrix combined according to a predetermined program of the directions, are sent to the inputs of BCL, BCC as six information signals, i.e. "forward", "backward" and "stop" for the lines and the columns concerning the ball in order to obtain the direction of the kicked ball.

The allotment of the probabilities is such that the maximum π_6 is allotted to the direction along which the ball may reach or at least better approach to a given aim. In FIG. 4C a point X in a generic zone is shown, which should reach an aim to the north-east of X in a probabilistic manner. Therefore π_6 is allotted to the direction NE, π_4 to the E, π_3 to the N, π_2 to the SE and π_1 to the NW.

Let us now describe by way of example how the ball is kicked: once the possession has taken place, the probability of that moment is considered, e.g. π_3, which is connected to the input 2 of K through J_1, the zone where the possession has occurred; e.g. Z1 enables also the input 3 of K which switches and its output is a logic 1 signal. If the output of this circuit K (one of the similar 60 circuits K) is connected through J_2 to the FORWARD control of BCL, this results in a displacement northwards of the counter relating to the lines of the ball signal. Similar considerations must be repeated for all the other 59 combinations.

To sum up, referring again to FIG. 1 and 2 the outputs of the blocks B4, B5, B4', B5', B14, B15, B18, B19 are respectively the information in digital form which refers to the geometric co-ordinates X and Y of a plane, in particular of the points which must be repre-

sented on it. We shall have in fact for the area A1 the signals xM and yM which, when at the input of the decoding and amplifying block B6, give the representation of the players of the team M on a plane of visualisation with distinct points, like that shown in FIG. 1. Analogously for the area A1' the outputs xA and yA of the automatic player will be given, for the area A3 the outputs xP and yP for the representation of the ball and for the area A1 the outputs PM and PA, which are respectively the only co-ordinates (abscissae) of the goalkeeper of the team M and that of the team A.

Analogical-type television representation

These information signals xM, yM, xA, yA, xP, yP, pM, pA can be sent alternatively either to the above mentioned decoding and amplifying circuits, or to the input of a network as illustrated in FIG. 3. This network, which allows a television display, gives a continuous-type cinematic representation.

With reference to FIG. 3, the type of representation described and illustrated here is based on the use of a colour cinescope C, in particular for trichromatic representations (red, green and blue) characterized by an area of visualisation G of proper size. We describe hereinafter by way of example the type of trichromatic representation, which allows in a simple manner the discrimination of the various bodies in movement. However representations in black and white are possible, for which the discrimination of the bodies is based on the different form. Of course the utilization of only three colours is not limitative with respect to other types of colours or a greater number of colours.

The device here described and schematically represented in FIG. 3, and generally all those devices deriving from it, is provided with inputs through which the information signals in digital form are sent (but also in analogical form, as will be seen later) which refer, as stated above, to the geometrical co-ordinates of the points in movement representing all the player as well as the ball and provided by a complex of circuits like that represented in the block diagram of FIG. 2.

The abscissa and ordinate information (x and y) must be provided separately, but it is obviously indispensable that they be provided contemporaneously if they refer to one single point for which oblique movements on the plane are foreseen (ball and players excluding the goalkeepers). All information is converted into an analogical form by means of digital-analogical converters CDA, provided with networks of weighted decodification. In order to give the points represented on the screen a naturally dynamic movement, including therein the normal components of acceleration and deceleration, all information is subsequently directed into filters F characterized by a high inertial coefficient.

A strictly constant voltage is added, by means of dividers P and adding amplifiers E, to the information relative to the points to which a partial zone of movement with respect to the whole area of play is allocated (in this case all players including the goal-keepers). This voltage is supplied by a "reference constants generator" K, but is different for the various information and suitable for allocating the points in the pertinent zones. The information thus elaborated is joined to that for which no elaboration was provided and orderly directed towards two series of reading selectors: vertical Sv and horizontal Sh.

Independent of the fact that either various paths and directions of movement in the plane (as for the players and the ball) or only one rectilinear movement are assigned to the points, the contemporary reading of two information signals takes place for each point. These are the vertical or ordinate voltage and the horizontal or abscissa voltage with the condition that for the points with only rectilinear movement the fictitious information of co-ordinate not given at the input of the device is generated. This information is necessary for the positioning in the area of the line of movement which would otherwise occupy one of the centre lines of the display area.

The reading of the information is controlled by means of a generator-codifier or "control unit" U, which can carry out with various criteria and different speeds the above-mentioned operation. In the case here discussed the reading of the information voltage is carried out successively in time, point by point, taking care to actuate with a slight delay, by means of a multiple timer T, the electric gun r, v, b, corresponding to the characteristic colour of the point. This is indispensable when using a chromatic cinescope, in fact the actuation of the gun contemporarily with the reading would not only determine the projection of the point in the non-relevant zone, but would also result in the appearance of an inexact colour.

Up to this point of the process, the information is still without a sufficient energy content to determine the deflection of the electronic pencils of the cinescope. Duly ordered in time, the information is then directed towards two d.c. power amplifiers Adh and Adv of analogical linear type, of which the first imposes the horizontal deflection and the second the vertical deflection. Of course the cinescope needs other service and auxiliary electric parameters, which however are all known, the most important of which are those relative to the focusing, the brightness, the acceleration of the electronic pencils and lastly the polarization of the major anode, the latter being provided by a special high-voltage feeder HV, separate and autonomous with respect to the basic feeder of all other circuits.

As far as the display surface G in the cinescope is concerned, the screen is covered with a superimposition. of transparent material by means of a simple superimposition

This panel has the double function of neutralizing within the acceptable limits possible dangerous radiations and allowing the creation of lines and other signs by means of a process of pantography and serigraphy with luminescent paints, which duly lighted may completely represent the limits of the playground and the various necessary symbols.

The device illustrated in FIG. 3 is moreover suitable to be connected to simulators of play which provide only analogical information, which would in this case be introduced downstream of the digital-analogical CDA converters, the presence of which is on the other hand indispensable in the example described. In so far as the components used for the various subcircuits of FIG. 3 are concerned, the digital-analogical converters CDA may consist of binary counters and resistors; the filters F, as is known, comprise resistors and capacitors; the amplifiers E may be made by transistors npn and resistors; the dividers P are usual potentiometers; ShM, ShA, SvM, SvA, . . . may be usual REED relays; the amplifiers Adh and Adv may be made by transistors npn

and resistors; the timer T may consist of a Miller circuit transistors, capacitors and resistors; K is a known multiple feeder, for generating constant reference voltages and currents; the control unit U comprises astable multivibrators.

Other possible modifications and/or additions can be made by those skilled in the art to the described embodiments of the device according to the present invention without departing form the scope defined by the appended claims. It is obvious that for example there are no limitations concerning the systems of projection of the images, for which reason the use of chromatic mask cinescopes, or "Cromatron" electrostatic, parallel line cinescopes, or even solid cinescope at present in the experimental phase is not excluded. Furthermore the formation of the picture-image can be obtained with a sequential or non-sequential (interlaced) scanning.

What we claim is:

1. An electronic device for the simulation of an animated game between two teams moving a ball or other projectile across a playing field, said device comprising:
   a. a display plane representing the playing field;
   b. means for displaying at any time on said display plane the position of each of said team members;
   c. means for representing on said display plane at any time the position of said ball;
   d. means for comparing the position of said ball with the positions of the closest players of each team and for deriving signals representing the direction of each of said closest players therefrom;
   e. means for changing the positions of said closest players toward the position of said ball, said comparing means indicating when the position of one of said closest players and said ball coincides;
   f. and means for automatically causing said ball to move to a new position, said new position being dependent upon which of said closest players reached said ball and the probable direction in which said ball would be projected by said player.

2. The device defined in claim 1 wherein said display plane is divided into zones, one zone for each player position on said teams.

3. The device defined in claim 2 wherein said means for indicating player and ball positions includes means for illuminating said display at said positions.

4. The device defined in claim 3 wherein said means for indicating the positions of said players comprises for each player a pair of counters, each of said counters representing one coordinate axis of a pair of axes and the value in said counters at any time representing a coordinate of the player position at that time, means for stepping said counters, and control means for causing said counters to step and to select the direction in

which each steps.

5. The device defined in claim 4 wherein said stepping means includes a source of electrical pulses, and wherein said control means includes gating means having as one input the output of said pulse source.

6. The device defined in claim 5 wherein said comparing means includes at least one comparator for each coordinate axis, each of said comparators having at least two outputs, one of said outputs becoming energized when the coordinate value of the ball's position is greater than the coordinate value of the player's position and the other of said outputs being energized when the coordinate value of the player's position is greater than that of the ball's.

7. The device defined in claim 6 further including means for connecting one output of said comparator to said gating means to cause said counters to count in a first direction, and means for connecting the other output of said comparator to said gating means to cause said counters to count in the other direction.

8. The device defined in claim 7 wherein each of said comparators also includes a third output which is energized when the coordinates of said ball and player coincide, and means for connecting said third output to said gating means to halt further stepping of said counters.

9. The device defined in claim 4 wherein said means for causing said ball to move to a new position includes at least a ball counter for each coordinate axis, the value of the contents of each said ball counter representing the coordinate position of said ball, means to step said ball counter, and ball gating means connected between said ball stepping means and said ball counter to control the stepping of said ball counter.

10. The device defined in claim 9 further including a weighting counter, means to step said counter to cause said counter to produce a sequentially changing number of output pulses, a decoder having inputs, means for applying the output pulses from said weighting counter and the output from said comparator to the inputs of said decoder to produce a decoded output therefrom, and means for applying the output from said decoder to said ball counters to step said counter and determine a new position for said ball.

11. The device defined in claim 1 wherein said display plane comprises the face of a cathode ray tube and wherein said means for indicating the positions of said players and said ball comprises the cathode ray of said cathode ray tube, a video generator circuit, and means for connecting said means for changing the positions of said players and said means for causing said ball to move to said video generating circuit.

12. The device defined in claim 11 wherein said connecting means includes digital-to-analog converters.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,874,669

DATED : April 1, 1975

INVENTOR(S) : Rosalba Ariano, et al

It is certified that error appears in the above—identified patent and that said Letters Patent are hereby corrected as shown below:

Title page, [76], line 2, "Danado" should read --Danato--

Column 9, line 41, "$\mu_i(\epsilon),(\gamma)$" should read --$\mu_i(\omega),(\sigma)$--

Column 12, line 45, "superimposition" should read --panel--

Signed and Sealed this

eighteenth Day of November 1975

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks